CBCS SCHEME

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18AE/AS35

Third Semester B.E. Degree Examination, June/July 2023
Mechanics of Fluids

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. Distinguish between the following : **(06 Marks)**
   i) Ideal fluid and Newtonian fluid
   ii) Dynamic viscosity and kinematic viscosity
   iii) Mass density and specific gravity

b. Explain the phenomenon of capillarity. Obtain an expression for capillary rise and capillary fall. **(10 Marks)**

c. State and prove 'Pascal's law. **(04 Marks)**

OR

2 a. State and Prove hydrostatic law. **(06 Marks)**

b. For a vertical plane surface submerged in liquid show that centre of pressure lies below centre of gravity of the vertical surface. **(08 Marks)**

c. A square aperture in the vertical side of a tank has one diagonal vertical and is completely covered by a plane plate hinged along one of the upper sides of aperture. The diagonal of the aperture are 2m long and tank contains a liquid of specific gravity 1.15.The centre of aperture is 1.5m below the free surface. Calculate the thrust exerted on the plate by the liquid and position of it centre of pressure. **(06 Marks)**

Module-2

3 a. Obtain an equation of stream function and potential function. Draw stream line and potential lines of sources flow. **(10 Marks)**

b. Derive continuity equation in the three dimensions, in the differential form and write the same for a steady incompressible flow. **(10 Marks)**

OR

4 a. For a fluid flow derive an expression for continuity equation in three dimensions in Cartesian coordinate. **(08 Marks)**

b. A source and sink of strength $4m^2/s$ and $8m^2/s$ are located at (-1, 0) and (1, 0) respectively. Determine the velocity and stream function at a point P(1, 1) which is lying on the flow net of resultant stream line. **(12 Marks)**

Module-3

5 a. State Bernoulli's theorem for steady flow of an incompressible fluid. Derive an expression for Bernoulli equation from Euler's equations, also state the assumptions. **(10 Marks)**

b. An oil of specific gravity 0.8 is flowing through a venturimeter having inlet diameter 20cm and throat diameter 10cm. The oil mercury differential manometer shows a reading of 25cm. Calculate the discharge of oil through horizontal venturimeter. Take $C_d = 0.98$. **(05 Marks)**

c. An orifice meter with orifice diameter 15cm is inserted in a pipe of 30cm diameter. The pressure difference is measured by a mercury oil differential manometer on the two sides of the orifice meter gives a reading of 50cm of mercury. Find the rate of flow of oil of specific gravity 0.9. When $C_d = 0.64$. **(05 Marks)**

OR

6 a. Using Buckingham's π-theorem, show that the velocity through a circular orifice is given by $V = \sqrt{2gH}\,\phi\left[\frac{D}{H}, \frac{\mu}{\rho VH}\right]$, where H is head causing flow. D is diameter of the orifice, μ is coefficient of viscosity, ρ is mass density and g is acceleration due to gravity. **(10 Marks)**

b. The efficiency η of a fan depends on the density ρ, the dynamic viscosity μ of the fluid, angular velocity 'w', diameter 'D' of the rotor and the discharge Q. Express η in term of dimensionless parameter [By using Rayleigh Metho] **(10 Marks)**

Module-4

7 a. Derive Von Karman's momentum integral equation for boundary layer flows. **(12 Marks)**

b. Oil with a free stream velocity of 2m/s flows over a thin plate 2m wide and 2m long. Calculate the boundary layer thickness and shear stress at the trailing end point and determine the total surface resistance of the plate. Take specific gravity as 0.86 and kinematic viscosity as $10^{-5} m^2/s$. **(08 Marks)**

OR

8 a. Define and obtain expression for,
   i) Displacement thickness
   ii) Momentum thickness
   iii) Energy thickness **(15 Marks)**

b. With a neat sketch, explain boundary layer concept. **(05 Marks)**

Module-5

9 a. Sketch the propagation of disturbance or pressure waves in compressible fluids, when mach number is greater than one, also explain with respect to the above,
   i) Mach angle
   ii) Zone of action
   iii) Zone of silence **(12 Marks)**

b. For a compressible flow undergoing adiabatic process, derive Bernoulli's equation. **(08 Marks)**

OR

10 a. Derive an expression for velocity of sound wave in a fluid. **(10 Marks)**

b. Find sonic velocity for the following fluids,
   i) Crude oil of specific gravity 0.8 and bulk modulus 153036 N/cm^2
   ii) Mercury having bulk modulus of 2648700 N/cm^2 **(05 Marks)**

c. Calculate the stagnation pressure, temperature and density on the stagnation point on the nose of a plane, which is flying at 800 Km/hr through still air having pressure 8.0N/cm^2(ahs) and temperature -10°C. Take R = 287 J/Kg K and K = 1.4. **(05 Marks)**

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